**RAID** - **Redundant Array of Independent Disks.**

The distribution of data between multiple drives can be managed by dedicated hardware or by software.

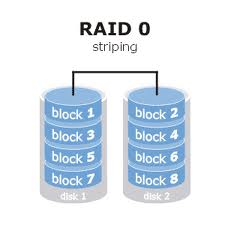
When using a software, most often than not it will be embedded in the operating system. It can also be a part of the firmware and drives that are supplied with the card.

**Different Types of RAID**

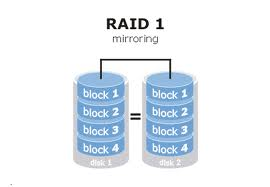
1. Software-based RAID - provided by many operating systems. A software layer sits above the (generally block-based) disk device drivers and provides an abstraction layer between the logical drives (RAIDs) and physical drives.

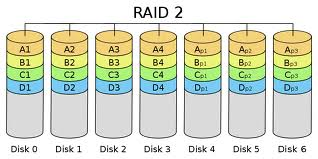
**Most common levels are:**

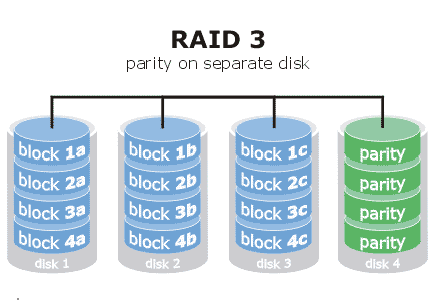
* **RAID 0** is all about performance, employing what’s called striping, where data is broken up into fragments and written across multiple drives, sort of treating them as one giant drive.



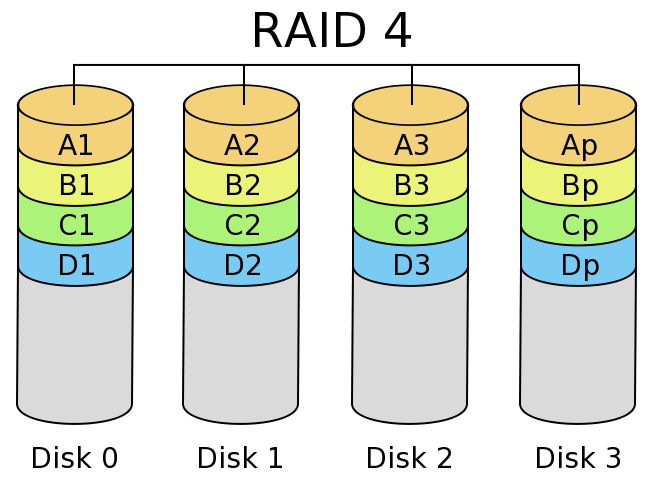
* **RAID 1** is the main configuration most novices should learn about. It writes, or mirrors, data to multiple disks, so you’ve got multiple hard drives that are exactly the same. Good for reliability of data.



* **RAID 2** stripes data like RAID 0, but at even smaller level (bits instead of blocks) and uses additional hard drives and what’s called Hamming code for error protection and parity which allows it to recover corrupt data. Guess what? No one uses it anymore, because it requires a ridiculous number of disks.
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* **RAID 3** stripes data across multiple drives as well, but at the byte level, and it has a single disk dedicated to data parity and error correction. Because of the byte level split, all the drives work together simultaneously as one unit, which means it can only do one one read or write operation at a time. Pretty rare to see, and nothing you, Joe Q. Consumer have to worry about. It’s good for high transfer rates (again, HD video editing comes to mind) with a measure of security that you don’t get with RAID 0, since you can lose a disk and still be okay. You need at least three disks for this party.



* **RAID 4** is a striping+parity disk setup too, but at the larger block level, so disks can be more independent, and you can have multiple read operations in different places going on.



* New file systems like btrfs (read as “BetterFS”) may replace the traditional software RAID by providing striping and redundancy at the file system object level.

### 2. Hardware-based RAID – uses different controllers, most of types usually do not need processor resources and most of the time BIOS can boot from them. Better error handling can occur when there is a tighter integration with the device.

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### 3. Firmware/Driver-based RAID – does not always protect the boot process and is generally impractical on desktop version of Windows. Hardware Raid controllers are expensive proprietary

### Network-attached storage – but not directly associated with RAID, [Network-attached storage](http://en.wikipedia.org/wiki/Network-attached_storage) (NAS) is an enclosure containing disk drives and the equipment necessary to make them available over a [computer network](http://en.wikipedia.org/wiki/Computer_network), usually [Ethernet](http://en.wikipedia.org/wiki/Ethernet). The enclosure is basically a dedicated computer in its own right, designed to operate over the network without screen or keyboard. It contains one or more disk drives; multiple drives may be configured as a RAID.

### Hot spares - when the system automatically replaces the failed drive with the spare, rebuilding the array with the spare drive included. This reduces the [mean time to recovery](http://en.wikipedia.org/wiki/Mean_time_to_recovery) (MTTR), though it doesn't eliminate it completely. Subsequent additional failure(s) in the same RAID redundancy group before the array is fully rebuilt can result in loss of the data; rebuilding can take several hours, especially on busy systems.

Rapid replacement of failed drives is important as the drives of an array will all have had the same amount of use, and may tend to fail at about the same time rather than randomly.[[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)] RAID 6 without a spare uses the same number of drives as RAID 5 with a hot spare and protects data against simultaneous failure of up to two drives, but requires a more advanced RAID controller. Further, a hot spare can be shared by multiple RAID sets.

### Terms to REMEMBER

Data Striping - a method of concatenating multiple drives into one logical storage unit. Striping involves partitioning each drive's storage space into stripes which may be as small as one sector (512 bytes) or as large as several megabytes. These stripes are then interleaved round-robin, so that the combined space is composed alternately of stripes from each drive. In effect, the storage space of the drives is shuffled like a deck of cards. The type of application environment, I/O or data intensive, determines whether large or small stripes should be used.

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### [Failure rate](http://en.wikipedia.org/wiki/Failure_rate)

1. Loss of a single drive and its rate is equal to the sum of individual drives' failure rates.
2. System failure is defined as loss of data and its rate will depend on the type of RAID.
   1. For RAID 0 this is equal to the logical failure rate, as there is no redundancy.
   2. For other types of RAID, it will be less than the logical failure rate, potentially approaching zero, and its exact value will depend on the type of RAID, the number of drives employed, and the vigilance and alacrity of its human administrators.

### Mean time to data loss (MTTDL) – Mean time to data loss of a given RAID may be higher or lower than that of its constituent hard drives, depending upon what type of RAID is employed. The referenced report assumes times to data loss are exponentially distributed. This means 63.2% of all data loss will occur between time 0 and the MTTDL. Click here for a sample of MTTDL computation

### [Mean time to recovery](http://en.wikipedia.org/wiki/Mean_time_to_recovery) (MTTR) - In arrays that include redundancy for reliability, this is the time following a failure to restore an array to its normal failure-tolerant mode of operation. This includes time to replace a failed disk mechanism as well as time to re-build the array (i.e. to replicate data for redundancy).

### Unrecoverable bit error rate (UBE) - This is the rate at which a disk drive will be unable to recover data after application of cyclic redundancy check (CRC) codes and multiple retries.

### Write cache reliability-Some RAID systems use [RAM](http://en.wikipedia.org/wiki/RAM) write cache to increase performance. A power failure can result in data loss unless this sort of [disk buffer](http://en.wikipedia.org/wiki/Disk_buffer) is supplemented with a battery to ensure that the buffer has enough time to write from RAM back to disk.

### [Atomic write](http://en.wikipedia.org/wiki/Atomicity_%28database_systems%29) failure

Also known by various terms such as torn writes, torn pages, incomplete writes, interrupted writes, non-transactional, etc.

Sources:

"Types of RAID." *Data Recovery Service in Houston, New York, Chicago, Boston, Los Angeles. Hard Drive Data Recovery, Raid Recovery*. Web. 19 Mar. 2012. <http://www.optimumrecovery.com/raid/types.html>.

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